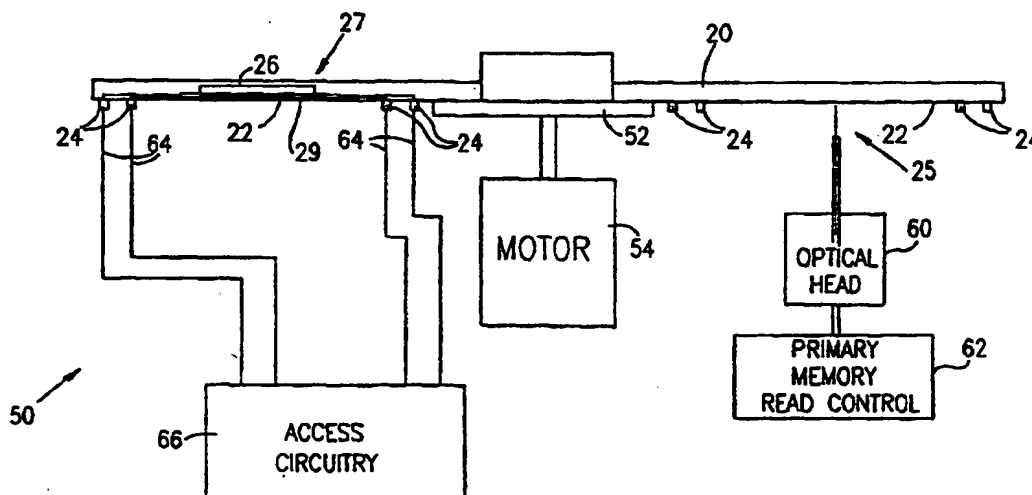




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(54) Title: CD WITH AUXILIARY ELECTRONIC CIRCUITRY



(57) Abstract

A memory disk (20) for insertion in a rotational drive (50), which includes an auxiliary circuit (27) fixed thereto. The auxiliary circuit (27) is coupled to access circuitry (66) associated with the drive (50) when the disk (20) is inserted therein, independent of the orientation of the disk (20) within the drive (50). The auxiliary circuit preferably includes a logic circuit, a processor and/or a secondary memory. The auxiliary circuit may be used to control access to the memory disk.

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CD WITH AUXILIARY ELECTRONIC CIRCUITRY**FIELD OF THE INVENTION**

The present invention relates generally to computer memory discs, and specifically to compact discs and compact disc readers.

BACKGROUND OF THE INVENTION

Compact discs (CDs) are the most common form of read-only memory storage for playback of recorded information, both of audio information and of computer records. Usually, the information is imprinted on one side of the CD, and is read by an optical reader within a CD-drive.

CDs are generally a permanent form of data storage, and once a CD is written on, it is not possible to change or write over its contents. In some cases, however, it is desired to have a supplementary memory on the CD, generally smaller than the CD's read-only memory, that can be overwritten and updated. For example, computer games frequently have a feature of saving the game status or game scores. Such information cannot be updated on CDs currently in the market.

CDs with a secondary memory are known in the art. For example, U.S. Patent 5,119,353 describes a CD which contains a secondary EEPROM memory and a CD-drive which reads the contents of the primary and secondary memories of the CD. However, the CD-drive of U.S. Patent 5,119,353 is complicated. It does not allow reading the secondary memory while the CD is rotating, so that the CD must stop rotating and be properly aligned before the secondary memory is read. Therefore, it is not possible to read from both the read-only and secondary memories simultaneously.

CDs are generally produced in multiple copies, by, on behalf of, or under license from the owner of the information stored thereon. Until recently, apparatus for writing on CDs was very expensive, so that it was not economical for a home user to buy such apparatus in order to produce unauthorized copies of CDs. Therefore, there was no need for extra protection to prevent unauthorized copies. However, recently the price of apparatus for writing on CDs has dropped to a few hundred dollars, so that the need for data protection arises.

SUMMARY OF THE INVENTION

It is an object of some aspects of the present invention to provide an improved CD which has an easily-accessed auxiliary circuit.

5 In some aspects of the present invention, the auxiliary circuit is accessed simultaneously with reading of the primary, read-only memory.

It is another object of some aspects of the present invention to provide an improved CD-drive which can access auxiliary circuits within CDs.

It is another object of some aspects of the present invention to provide a method of CD data protection using a secondary memory or other auxiliary circuit within the CD.

10 In preferred embodiments of the present invention, a CD includes an auxiliary circuit embedded within, or fixed on, the CD, at any suitable location, and electrical leads coupled thereto. The auxiliary circuit preferably includes a memory circuit, but alternatively or additionally may include a processor, a logic array or any other suitable circuit. When the CD is loaded into a drive having suitable access circuitry, the leads of the auxiliary circuit are
15 electrically coupled to the access circuitry, regardless of the orientation of the CD within the drive. Preferably, the auxiliary circuit is electrically coupled to the access circuitry for the whole period the CD is within the drive. The CD is coupled to the access circuitry such that rotational movements of the CD do not substantially affect the electrical coupling.

In some preferred embodiments of the present invention, the electrical coupling is
20 achieved by means of a plurality of thin concentric rings of a conductive material, which are deposited on, or otherwise fixed to, the CD's surface. Preferably, the conducting concentric rings are located on the side of the CD from which the primary memory is read, most preferably adjacent to the outer or inner circumference of the CD, outside the area used by the primary memory. Alternatively or additionally, the rings may be on the side of the CD opposite the
25 primary memory side. Further alternatively or additionally, the auxiliary circuit may be coupled to the access circuitry by means of contacts situated on the outer and/or inner edges of the CD.

A CD-drive or player, in accordance with some preferred embodiments of the present invention, comprises in addition to a read head for reading the primary memory, such as an optical head, as is well known in the art, access circuitry for accessing the auxiliary circuit. In an
30 exemplary embodiment, the auxiliary circuit comprises a secondary memory, and the access circuitry comprises a device for reading and, preferably, writing to the secondary memory. Preferably, for each concentric ring on the CD, the CD-drive includes a direct contact, referred to herein as a wiper, which contacts the CD and passes electrical signals to and from the auxiliary circuit. While the CD rotates, the wipers remain motionless in substantially constant
35 contact with their respective rings. Thus, the CD player can access the auxiliary circuit at any time without delay and without interfering with reading the primary memory of the CD.

Preferably, some or all of the wipers are held together in a single read/write arm, allowing easy, automatic positioning of the wipers on the CD. Further preferably, the wipers are

located in the CD drive diametrically opposite the read head, so that the wipers and read head do not interfere with each other.

In other preferred embodiments of the present invention, signals are transferred to, and received from, the auxiliary circuit by non-contact inductive or capacitively-coupled transfer. Such non-contact transfer is known in the art and is widely used, for example, in smart cards.

In some preferred embodiments of the present invention, the CD-drive is also compatible with CDs which do not have an auxiliary circuit. Preferably, the drive recognizes automatically whether the CD has an auxiliary circuit and accordingly applies the wipers, or other coupling leads, to the CD. Alternatively, the drive applies the wipers to the CD for a test period to check whether there is an auxiliary circuit within the CD. If no signals are received, the wipers are preferably removed from the CD.

In preferred embodiments of the present invention, the auxiliary circuit comprises an integrated circuit, most preferably a non-volatile memory circuit. Alternatively or additionally, the auxiliary circuit may comprise one or more integrated circuits of any suitable type known in the art. Preferably, the integrated circuits are mounted on an electronic circuit board produced on a thin substrate, for example, a flexible or rigid printed circuit board laminate, a ceramic and/or other substrate material. It will be appreciated that the auxiliary circuit is not limited to one integrated circuit, but rather may include a plurality of integrated circuits located at any suitable positions within or mounted on the CD.

In some preferred embodiments of the present invention, the auxiliary circuit is embedded within the CD. Electrical conductors within the CD couple the auxiliary circuit to the contacts on the surface of the CD.

In other preferred embodiments of the present invention, the auxiliary circuit is fixed to a surface of the CD in an area in which the auxiliary circuit will not interfere with reading from the primary memory. In some of these embodiments, the auxiliary circuit comprises a flexible printed circuit, which is attached to a surface of the CD. Preferably, the flexible printed circuit has an annular shape and includes the contact rings by means of which the CD drive accesses the auxiliary circuit.

In some preferred embodiments of the present invention, the auxiliary circuit includes a secondary memory comprising a read/write memory or alternatively a read-only memory. Preferably, the secondary memory is non-volatile, so as to retain data stored on it even when the power connection is removed.

In some preferred embodiments of the present invention, the auxiliary circuit includes a processor of any suitable type known in the art. Preferably, the processor is pre-programmed to carry out specific tasks. For example, the processor may be used to run software contained within the primary memory. In another example, the processor may count the uses of the primary memory and/or track the calendar date, and disable use of the CD after a predetermined number of uses or length of time. This feature is useful when the contents of the CD primary

memory are to be licensed or rented to a user for a predetermined period or number of uses, rather than sold outright. Thus, for example, the owner of a game can give bonuses in the form of extra periods of use to successful players.

5 In some preferred embodiments of the present invention, the auxiliary circuit is used for CD copy prevention.

10 In one such preferred embodiment, the auxiliary circuit includes a secondary memory, which is preferably copy protected, as is known in the art. The secondary memory contains identification information which is necessary in order to read and use the contents of the primary memory of the CD. Preferably, the primary memory contains a software program which includes a verification routine. The verification routine is run by a processor associated with the CD drive before and/or during the use of the software. The processor checks whether the identification information on the secondary memory matches a predetermined segment of the primary memory. Alternatively or additionally, the drive which reads from the CD is pre-programmed with the verification routine, and checks the identification information before reading from the CD. If a user makes an unauthorized copy of the CD, the secondary memory contents are not copied. As a result, the verification software routine will recognize that the required identification information is missing, and will prevent usage of the CD.

15 In other preferred embodiments of the present invention, the identification information on the secondary memory is compared with an external code received, for example, from a smart card or directly from the keyboard.

20 Alternatively or additionally, the contents of the primary memory are in encoded form, and the secondary memory includes a key needed to decode the primary memory.

25 In further preferred embodiments of the present invention, the auxiliary circuit includes a PAL logic array and/or a processor which decode or perform other encryption processing with or on the contents of the primary memory or otherwise prevent unauthorized access to the primary memory.

30 Preferably, the contents of the auxiliary circuit are copy-protected, as is known in the art, making it much more difficult to copy the contents of the auxiliary circuit than the primary memory. The auxiliary circuit preferably includes an integrated circuit containing protected read-only sectors which contain a chip-code, pre-programmed at the time of manufacture, as is known in the art. The CD-drive accesses the auxiliary circuit only if the chip code is correct. Copying such a code requires fabricating an integrated circuit, which is not feasible for individual users.

35 There is therefore provided, in accordance with a preferred embodiment of the invention, a memory disk for insertion in a rotational drive, the disk including an auxiliary circuit fixed thereto, which auxiliary circuit is coupled to access circuitry associated with the drive when the disk is inserted therein, independent of the orientation of the disk within the drive.

Preferably, the auxiliary circuit is coupled substantially continuously to the access circuitry while the disk rotates in the drive. Further preferably, the auxiliary circuit is coupled substantially continuously to the access circuitry when the disk is within the drive.

5 Preferably, the disk includes an optical primary memory. Further preferably, the disk includes a CD-ROM.

Preferably, the auxiliary circuit includes a logic circuit. Alternatively or additionally, the auxiliary circuit includes a processor. Further alternatively or additionally, the auxiliary circuit includes a secondary memory.

10 Preferably, the secondary memory includes a non-volatile electronic memory. Further preferably, the secondary memory includes a read/write memory. Most preferably, the secondary memory includes an EEPROM.

Preferably, the auxiliary circuit is embedded within the disk. Alternatively or additionally, the auxiliary circuit is fixed to a surface of the disk.

15 In a preferred embodiment of the present invention, the auxiliary circuit contains a code for controlling access to the primary memory.

Preferably, the disk includes a plurality of concentric conductive rings fixed to the disk and electrically coupled to the auxiliary circuit, for coupling the auxiliary circuit to the access circuitry.

20 Preferably, the disk includes at least one insulating ring between a pair of adjoining conductive rings.

Preferably, the primary memory is read from an area on a front side of the disk, and at least some of the concentric rings are fixed to a back side of the disk opposite the front side.

25 Alternatively or additionally, the primary memory is read from an area on a front side of the disk, and at least some of the concentric rings are fixed to the front side. Preferably, the concentric rings are located outside the area from which the primary memory is read.

30 Alternatively or additionally, the auxiliary circuit is contactlessly coupled to the access circuitry. Preferably, the auxiliary circuit is inductively or electromagnetically coupled to the access circuitry. Further preferably, the auxiliary circuit is coupled to the access circuitry through RF signals. Preferably, the auxiliary circuit includes an antenna for contactless coupling with the access circuitry. Further preferably, the antenna includes concentric rings. Preferably, the auxiliary circuit includes a rectifier, for supplying energy to the auxiliary circuit.

35 There is also provided, in accordance with a preferred embodiment of the invention, a rotating drive for receiving a disk having a primary memory and an auxiliary circuit, the drive including a read head for reading data from the primary memory, and access circuitry for communicating with the auxiliary circuit independent of the orientation of the disk within the drive.

Preferably, the access circuitry communicates with the auxiliary circuit substantially continuously while the disk is in the drive.

Preferably, the access circuitry includes one or more wipers which contact ports on the memory disk that are electrically coupled to the auxiliary circuit.

Alternatively or additionally, the access circuitry accesses the auxiliary circuit without closing a physical contact therewith.

5 Preferably, the access circuitry includes an RF coupling circuit.

Preferably, the access circuitry includes a contactless transceiver for power transmission and information transmission and reception.

Preferably, the read head includes an optical head.

10 Preferably, the drive receives disks having no auxiliary circuit, and wherein the read head reads data from such disks.

Preferably, the drive determines whether disks received by the drive include auxiliary circuits.

15 There is also provided, in accordance with a preferred embodiment of the invention, a method of reading data from a memory disk having a primary memory and an auxiliary circuit, including reading a code from the auxiliary circuit and controlling access to the primary memory based on the code.

Preferably, controlling access to the primary memory includes comparing the code from the auxiliary circuit to a reference stored in the primary memory.

20 Preferably, controlling access to the primary memory includes decoding the contents of the primary memory using the code.

Further preferably, controlling access based on the code includes comparing the code to a reference external to the memory disk.

25 There is also provided, in accordance with a preferred embodiment of the present invention, a method of reading data from a memory disk having a primary memory and an auxiliary circuit, including reading data from the primary memory and processing the data using the auxiliary circuit.

Preferably, processing the data includes verifying a code stored in the primary memory.

Preferably, processing the data includes decoding the data.

30 Further preferably, processing the data includes running a software routine using a processor in the auxiliary circuit.

The present invention will be more fully understood from the following detailed description of the preferred embodiments thereof, taken together with the drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of a CD with an auxiliary circuit, in accordance with a preferred embodiment of the present invention;

Fig. 2 is a cross-sectional view of the CD of Fig. 1 taken along line II-II;

5 Fig. 3 is a schematic illustration of a CD-drive in which the CD of Fig. 1 is inserted, in accordance with a preferred embodiment of the present invention;

Fig. 4 is a sectional view of a CD with an auxiliary circuit, in accordance with another preferred embodiment of the present invention;

10 Fig. 5 is a schematic illustration of a CD-drive in which the CD of Fig. 4 is inserted, in accordance with another preferred embodiment of the present invention;

Fig. 6 is a flow chart illustrating a method for reading from a CD, in accordance with a preferred embodiment of the present invention; and

Fig. 7 is a schematic view of a CD with an auxiliary circuit, in accordance with still another preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 is a schematic illustration of a compact disk (CD) 20, in accordance with a preferred embodiment of the invention. CD 20 comprises a primary memory 25, preferably an optical memory, which is read from a primary memory area 22 on a front surface 23 of the CD, by an optical read head, as is known in the art.

Fig. 2 shows a cross-sectional view of CD 20, taken along line II-II. The thickness of the CD is exaggerated for the sake of clarity of illustration. An auxiliary electronic circuit 27 is embedded within CD 20. Circuit 27 preferably comprises a secondary memory, most preferably including at least one memory chip 26, but may, alternatively or additionally, include a processing component and/or other circuit elements known in the art. Wires 28, preferably embedded in CD 20, connect auxiliary circuit 27 to a plurality of concentric, electrically conducting rings 24, for transferring power, ground and signals to and from memory 26, to enable reading from and, preferably, writing to the memory.

Rings 24 are deposited on, glued to, or otherwise fixed to, surface 23. Preferably, rings 24 are inside the inner bounds of area 22, as shown in Fig. 1, and/or beyond the outer bounds of the area, so as not to interfere with reading of primary memory 25.

Rings 24 are preferably narrow, so as to take up minimal space on CD 20. Preferably, rings 24 comprise a highly conductive material such as gold-plated copper or aluminum.

Preferably, at least two concentric rings 24 are fixed on CD 20, more preferably four rings 24. When four rings are used, as shown in Fig. 1, two rings 32 and 34 serve as power and ground connections, and the other two rings 36 and 38 are used for a serial data signal. Alternatively, the same rings 24 may be used for both transfer of data and power, for example by modulating the information signals on the power supply signal, so that two rings may suffice. Preferably, a protocol such as the I²C bus protocol, is used to control the serial bi-directional flow of data from and to circuit 27. The I²C protocol is described, for example, in "Application notes and Development Tools for 80C51 Microcontrollers", published in the Philips Semiconductors Data Handbook (January 1992), and incorporated herein by reference.

Preferably, circuit 27 comprises an EEPROM or other non-volatile memory, but it may, alternatively or additionally, comprise a memory circuit of any suitable type known in the art, or a combination of memory circuits of different types. Further preferably, memory chip 26 and/or other components of circuit 27 are mounted on and coupled electrically to an electronic circuit board 29 printed on a thin substrate, such as a flexible or rigid printed circuit board laminate, or a ceramic or other substrate material known in the art, which is fixed to CD 20. Memory chip 26 or other components of circuit 27 may be of any size used in the art, necessary for the specific purpose of the circuit. If circuit 27 is used for data protection, it is generally sufficient that memory 26 have a capacity of a few tens of bytes. Alternatively, if circuit 27 is used for saving game status information, it may have a capacity of 16K or more.

Fig. 3 shows a CD-drive 50 for reading CD 20, in accordance with a preferred embodiment of the present invention. CD 20 is placed within CD-drive 50 on a plate 52 coupled to a motor 54, which rotates plate 52 along with CD 20, as known in the art. An optical head 60, also known in the art, is controlled by controller 62 to read the contents of primary memory 25 of CD 20.

Drive 50 comprises electrical contacts, referred to herein as wipers 64, which contact respective rings 24 so as to access the secondary memory on chip 26. Preferably, wipers 64 comprise a conductive material with low friction and wear resistant characteristics, of any suitable type known in the art. Preferably, each of wipers 64 has two positions, a contact position in which it contacts its respective ring 24, and a rest position in which it does not form contact with CD 20.

After CD 20 is inserted into drive 50, wipers 64 contact respective rings 24, and preferably remain in contact with the rings during the whole period during which CD 20 is within drive 50. Alternatively, to reduce wear on wipers 64 and rings 24, the wipers contact the rings only when it is desired to read from or write to auxiliary circuit 27. It is noted that this latter alternative is not necessarily slower than having the wipers in constant contact, since the wipers may be brought into contact with the rings before the actual read or write, without interfering with the reading of the primary memory of CD 20.

Preferably, wipers 64 are electrically and mechanically coupled to access circuitry 66, which passes power and signals to and from auxiliary circuit 27 of CD 20 and controls the positions of the wipers with respect to rings 24. As shown in Fig. 3, wipers 64 are preferably situated diametrically opposite optical head 60 so as not to interfere with its operation.

Preferably, drive 50 is compatible with CDs currently in the market. When a CD is inserted in drive 50, the drive recognizes whether the CD has an auxiliary circuit and accordingly applies the wipers to the CD. Preferably, wipers 64 are placed on the surface of CD 20 for a test period. If contact is established with rings 24, drive 50 recognizes the existence of auxiliary circuit 27. However if no signals are received by wipers 64 the wipers are preferably removed from CD 20.

Alternatively, the presence of auxiliary circuit 27 is recognized by means of optical, electrical and/or mechanical recognition of rings 24 or of an extra feature added for recognition purposes. Further alternatively, the user of CD-drive 50 sets the operation mode of the drive according to the type of the CD in use.

Fig. 4 is a schematic, sectional illustration of a CD 90, in accordance with another preferred embodiment of the present invention. Information and power are passed between auxiliary circuit 92 of CD 90 and an access circuit 94 of a CD-drive 96, by inductive, capacitive and/or other electromagnetic coupling between access circuitry 94 and rings 24, which are coupled with circuit 92. There is substantially no physical contact between the access circuitry and the rings. Preferably, the coupling is achieved by means of RF or other electromagnetic

fields, as are known in the art of contactless smart cards, for example, as described in the "CardTech/SecurTech '96" Conference Proceedings, (CardTech/SecurTech Inc., Rockville, Maryland, May, 1996), which is incorporated herein by reference.

5 Rings 24 and access circuitry 94 are preferably designed so as to optimize the inductive or electromagnetic coupling between them. Preferably, access circuit 94 comprises an antenna 99, which transmits and receives the RF or other electromagnetic field to and from rings 24. Preferably, a conversion circuit 98, such as a full wave bridge rectifier, is connected to circuit 92 and rings 24 and performs energy conversion from RF or other electromagnetic energy to DC power. It should be appreciated that in this preferred embodiment, rings 24 may be embedded
10 within CD 90, since there is no physical contact between circuitry 94 and rings 24.

Fig. 5 is a schematic, sectional illustration of a CD 120, in accordance with another preferred embodiment of the present invention. A front side 42 of CD 120 includes primary memory 25 of CD 120. A reverse side 44 of CD 120 includes concentric rings 24. Preferably, CD 120 includes enough rings 24 to allow parallel addressing of embedded secondary memory
15 chips 26 or other components in auxiliary circuit 27. Preferably, CD 120 includes isolating rings 46, situated between adjoining conducting rings 24 and protruding beyond rings 24 so as to guide wipers 64 onto rings 24, as described below. It is noted that the thickness of rings 24 and 46 relative to surface 44 is exaggerated in the figures.

As shown in Fig. 5, CD 120 includes an auxiliary circuit 27, comprising a plurality of
20 memory chips 26, and a processor 118. Preferably, memory chips 26 and processor 118 are placed within CD 120 in such positions as to allow smooth rotation of the CD. It is noted that although chips 26 are preferably embedded within CD 120, some or all of chips 26 or processor 118 may also be fixed externally to CD 120, for example on its back side 44. Processor 118 may be any processor known in the art such as a digital or analog processor. Processor 118 may be
25 used, for example, to run a software package stored in the primary memory of CD 120.

Fig. 6 shows another CD-drive 70, which is compatible with CD 120 of Fig. 5, in accordance with a preferred embodiment of the present invention. Drive 70 comprises an arm 78, including a plurality of wipers 64, which engages rings 24 situated on side 44 of CD 120. Preferably, wipers 64 are narrower than rings 24, so as not to fit too tightly in grooves 49 and
30 thus impede the rotation of CD 120. Drive 70 also comprises an optical head 60 which reads primary memory 25 from side 42 of CD 120.

In other preferred embodiments of the present invention, not shown in the figures, rings 24 may be situated on an outer edge 30 and/or on an inner edge 40 of CD 120. Alternatively, plate 52 of CD-drive 70 may include a raised hub, having electrical contacts thereon, which
35 engage respective contacts on inner edge 40.

Alternatively, the principles of the present invention may also be applied to produce a CD-drive in which the wipers comprise concentric rings and the leads of the auxiliary circuit are connected to small pads situated on the surface of the CD. The small pads remain substantially

constantly in electrical contact with the wipers, and thus the auxiliary circuit is in substantially constant contact with the CD-drive.

Fig. 7 is a flow chart illustrating the steps performed by a CD-drive in reading from a CD with an auxiliary circuit 27 used for CD copy prevention, in accordance with a preferred embodiment of the present invention. In this embodiment, auxiliary circuit 27 comprises a secondary memory containing an identification code, which can be verified against all or part of the contents of primary memory 25 of the CD. The secondary memory is preferably copy protected, as is known in the art. Preferably, a verification routine is stored in the primary memory. Alternatively or additionally, the CD-drive is pre-programmed with the verification routine.

A processor associated with the CD-drive or, alternatively, included in auxiliary circuit 27 on the CD runs the verification routine and checks the identification code. The processor blocks access to the primary memory unless the secondary memory contains the correct code. Thus, illegal copies of the primary memory are substantially unusable without a copy of the secondary memory. Thus, it is also possible to copy-protect CDs which do not contain software, such as audio CDs.

In preferred embodiments of the present invention providing copy protection, the auxiliary circuit preferably comprises a copy-protected read-only memory so that the identification code cannot be changed inadvertently or by intervention of a user of the CD. Alternatively, the secondary memory comprises read/write memory so that the verification routine may change the code periodically according to program instructions within the primary memory of the CD, in order to obstruct unauthorized code detection.

The identification code may be checked for correctness in many ways. Preferably, the primary memory contains another copy of the identification code, and when there is an attempt to read from the primary memory, the codes are compared. If the codes match, the software reads the required sector of the CD. However, if the codes do not match, access to the primary memory is denied.

Alternatively or additionally, the identification code on the secondary memory is compared to an identification code on external media, such as a magnetic card or a smart card.

One advantage in using the secondary memory to hold the identification code is that the code may be read at any time, without interfering with reading from the primary memory. Thus, confirmation may be performed frequently, or a long and complex identification code may be used without impeding the use of the CD.

Further alternatively or additionally, the contents of the primary memory are in encoded form. A processor associated with the CD-drive decodes the contents of the primary memory using the identification code within the secondary memory. The decoding process may include frequent access to the secondary memory, without impeding use of the primary memory, since such access does not interfere with reading the primary memory.

Fig. 8 shows a CD 140 in accordance with another preferred embodiment of the present invention. An auxiliary circuit 142 including a PAL 144, or other logic circuit, is fixed to a surface 146 of CD 140. Preferably, auxiliary circuit 142 comprises a flexible printed circuit 143, as is known in the art, which is attached to surface 146 using an adhesive or any other attachment method. Preferably, as shown in Fig. 7, printed circuit 143 is annular in shape and includes a plurality of concentric conducting rings 148, which provide electrical contact to auxiliary circuit 142, as described above. Alternatively, auxiliary circuit 142 may be imprinted, or otherwise deposited, on surface 146.

In a preferred embodiment of the present invention, primary memory 150 of CD 140 is in encoded form. A CD-drive, such as drive 50 in Fig. 3, which reads the contents of primary memory 150, is programmed to pass these contents through PAL 144 in order to decode the information on primary memory 150. Since PAL 144 is copy -protected, unauthorized copies of CD 140 will not include a suitably-programmed PAL and will therefore be substantially unusable.

It is noted that more than one auxiliary circuit may be incorporated within a CD. Thus, a CD may have two or more such circuits with separate contact systems, and possibly different purposes, accessed from different areas of the surface of the CD.

Although the above preferred embodiments are described with reference to a CD with optical read-only memory, it will be understood to those skilled in the art that the principles of the present invention can be applied to other rotating data storage media, such as CD-R, DVD, DVD-R, CD-I (a new high density disk technology), or other memory disks known in the art, which store information optically, electronically, mechanically, or magnetically, for example.

It will be appreciated that the preferred embodiments described above are cited by way of example, and the full scope of the invention is limited only by the claims.

CLAIMS

1. A memory disk for insertion in a rotational drive, said disk comprising an auxiliary circuit fixed thereto, which auxiliary circuit is coupled to access circuitry associated with the drive when the disk is inserted therein, independent of the orientation of the disk within the drive.
2. The disk of claim 1, wherein the auxiliary circuit is coupled substantially continuously to the access circuitry while the disk rotates in the drive.
3. The disk of claim 1 or claim 2, wherein the auxiliary circuit is coupled substantially continuously to the access circuitry when the disk is within the drive.
4. The disk of any of the preceding claims, wherein the disk comprises an optical primary memory.
5. The disk of claim 4, wherein the disk comprises a CD-ROM.
6. The disk of any of the preceding claims, wherein the auxiliary circuit comprises a logic circuit.
7. The disk of any of the preceding claims, wherein the auxiliary circuit comprises a processor.
8. The disk of any of the preceding claims, wherein the auxiliary circuit comprises a secondary memory.
9. The disk of claim 8, wherein the secondary memory comprises a non-volatile electronic memory.
10. The disk of claim 8 or claim 9, wherein the secondary memory comprises a read/write memory.
11. The disk of claim 10, wherein the secondary memory comprises a EEPROM.
12. The disk of any of the preceding claims, wherein the auxiliary circuit is embedded within the disk.

13. The disk of any of the preceding claims, wherein the auxiliary circuit is fixed to a surface of the disk.

14. The disk of any of the preceding claims, wherein the auxiliary circuit contains a code for controlling access to the primary memory.

15. The disk of any of the preceding claims, and comprising a plurality of concentric conductive rings fixed to the disk and electrically coupled to the auxiliary circuit, for coupling the auxiliary circuit to the access circuitry.

16. The disk of claim 15, and comprising at least one insulating ring between a pair of adjoining conductive rings.

17. The disk of claim 15 or claim 16, wherein the primary memory is read from an area on a front side of the disk, and wherein at least some of the concentric rings are fixed to a back side of the disk opposite the front side.

18. The disk of claim 15 or claim 16, wherein the primary memory is read from an area on a front side of the disk, and wherein at least some of the concentric rings are fixed to the front side.

19. The disk of claim 18, wherein the concentric rings are located outside the area from which the primary memory is read.

20. The disk of any of claims 1-14, wherein the auxiliary circuit is contactlessly coupled to the access circuitry.

21. The disk of claim 20, wherein the auxiliary circuit is electromagnetically coupled to the access circuitry.

22. The disk of claim 20, wherein the auxiliary circuit is inductively coupled to the access circuitry.

23. The disk of any of claims 20-22, wherein the auxiliary circuit is coupled to the access circuitry through RF signals.

24. The disk of any of claims 20-23, wherein the auxiliary circuit comprises an antenna for contactless coupling with the access circuitry.
- 5 25. The disk of claim 24, wherein the antenna comprises concentric rings.
26. The disk of any of claims 20-25, wherein the auxiliary circuit comprises a rectifier, for supplying energy to the auxiliary circuit.
- 10 27. A rotating drive for receiving a disk having a primary memory and an auxiliary circuit, said drive comprising:
a read head for reading data from the primary memory; and
access circuitry for communicating with the auxiliary circuit independent of the orientation of the disk within the drive.
- 15 28. The drive of claim 27, wherein the access circuitry communicates with the auxiliary circuit substantially continuously while the disk is in the drive.
- 20 29. The drive of claim 27 or claim 28, wherein the access circuitry comprises one or more wipers which contact ports on the memory disk that are electrically coupled to the auxiliary circuit.
30. The drive of claim 27 or claim 28, wherein the access circuitry accesses the auxiliary circuit without closing a physical contact therewith.
- 25 31. The drive of claim 30, wherein the access circuitry comprises an RF coupling circuit.
32. The drive of any of claims 27-31, wherein the read head comprises an optical head.
33. The drive of any of claims 27-32, wherein the drive receives disks having no auxiliary circuit, and wherein the read head reads data from such disks.
- 30 34. The drive of claim 33, wherein the drive determines whether disks received by the drive include auxiliary circuits.

35. A method of reading data from a memory disk having a primary memory and an auxiliary circuit, comprising:

reading a code from the auxiliary circuit; and

controlling access to the primary memory based on the code.

5

36. The method of claim 35, wherein controlling access to the primary memory comprises comparing the code from the auxiliary circuit to a reference stored in the primary memory.

37. The method of claim 35 or claim 36, wherein controlling access to the primary memory
10 comprises decoding the contents of the primary memory using the code.

38. The method of any of claims 35-37, wherein controlling access based on the code comprises comparing the code to a reference external to the memory disk.

15 39. A method of reading data from a memory disk having a primary memory and an auxiliary circuit, comprising:

reading data from the primary memory; and

processing the data using the auxiliary circuit.

20 40. The method of claim 39, wherein processing the data comprises verifying a code stored in the primary memory.

41. The method of claim 39 or claim 40, wherein processing the data comprises decoding
the data.

25

42. The method of any of claims 39-41, wherein processing the data comprises running a software routine using a processor in the auxiliary circuit.

FIG. 1

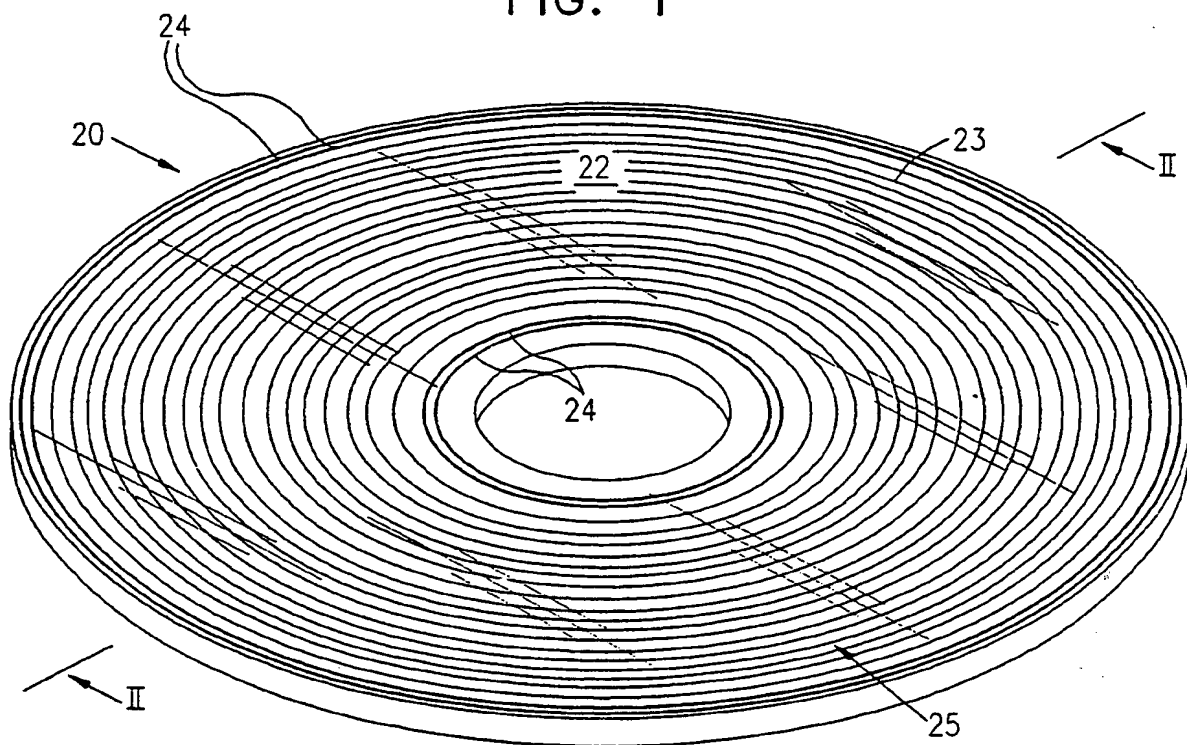
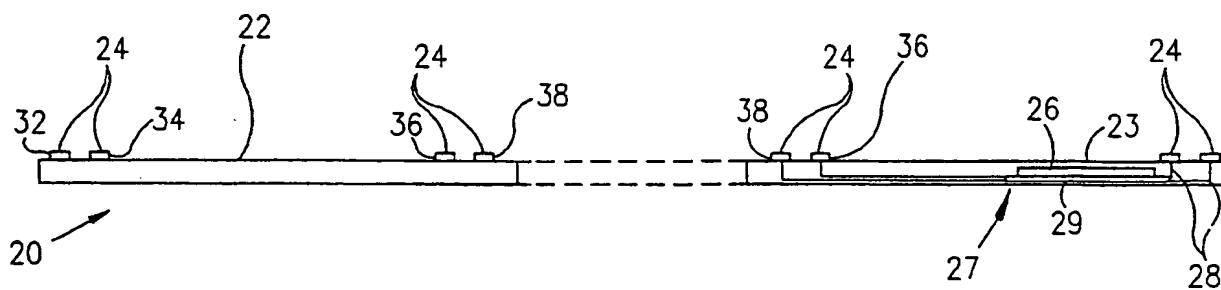


FIG. 2



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FIG. 3

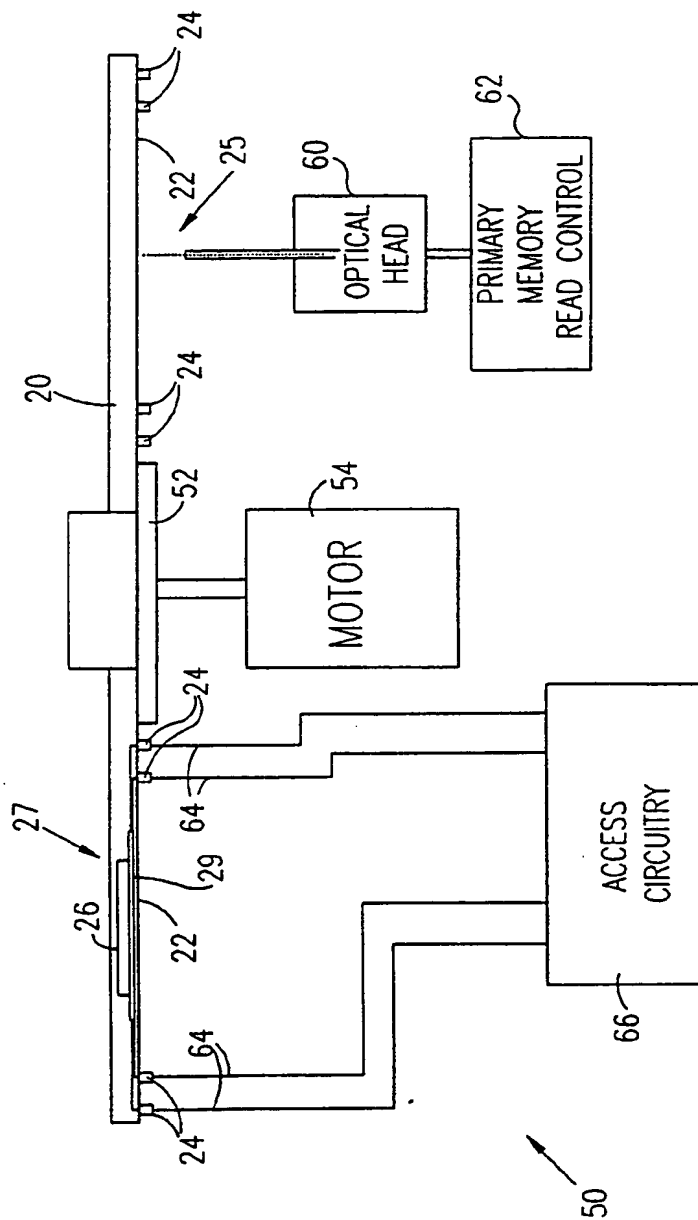
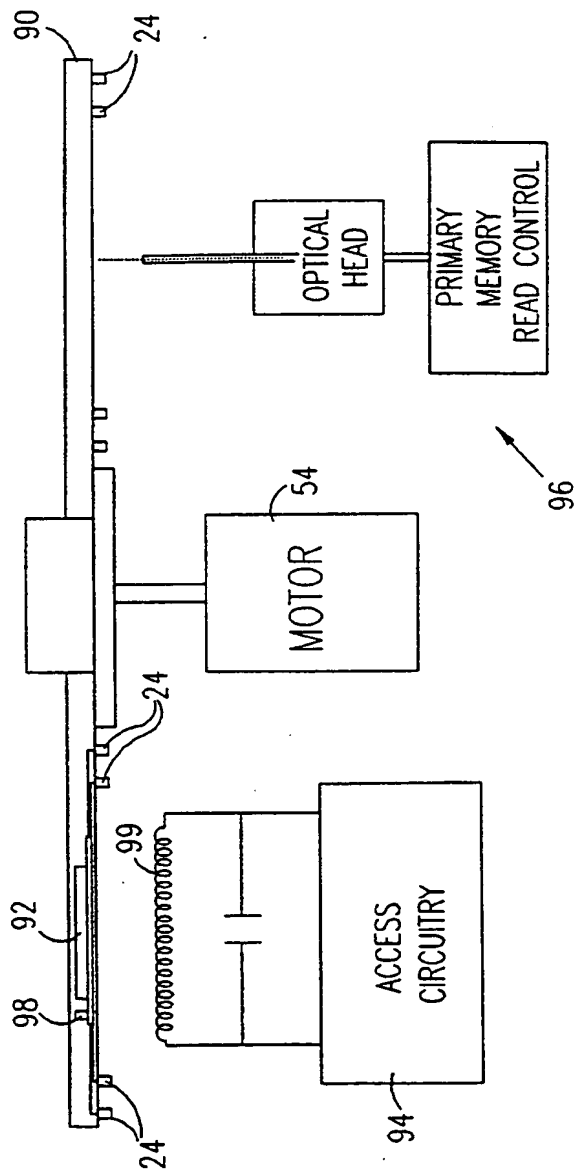


FIG. 4



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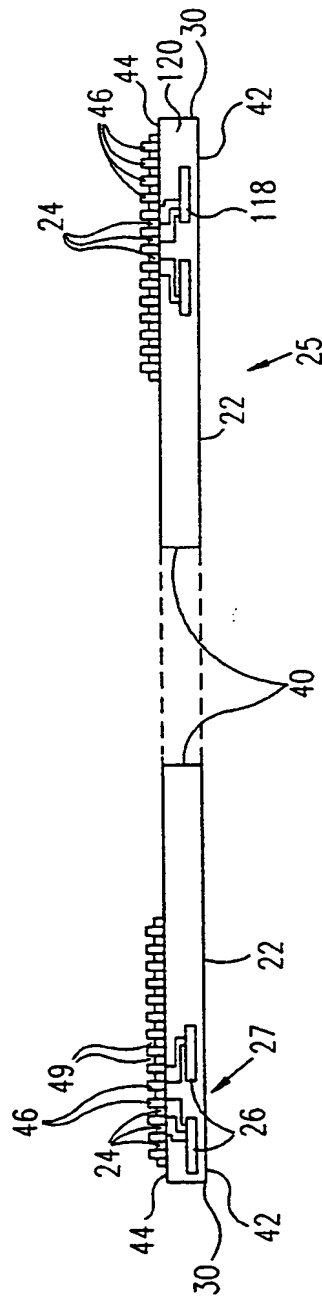
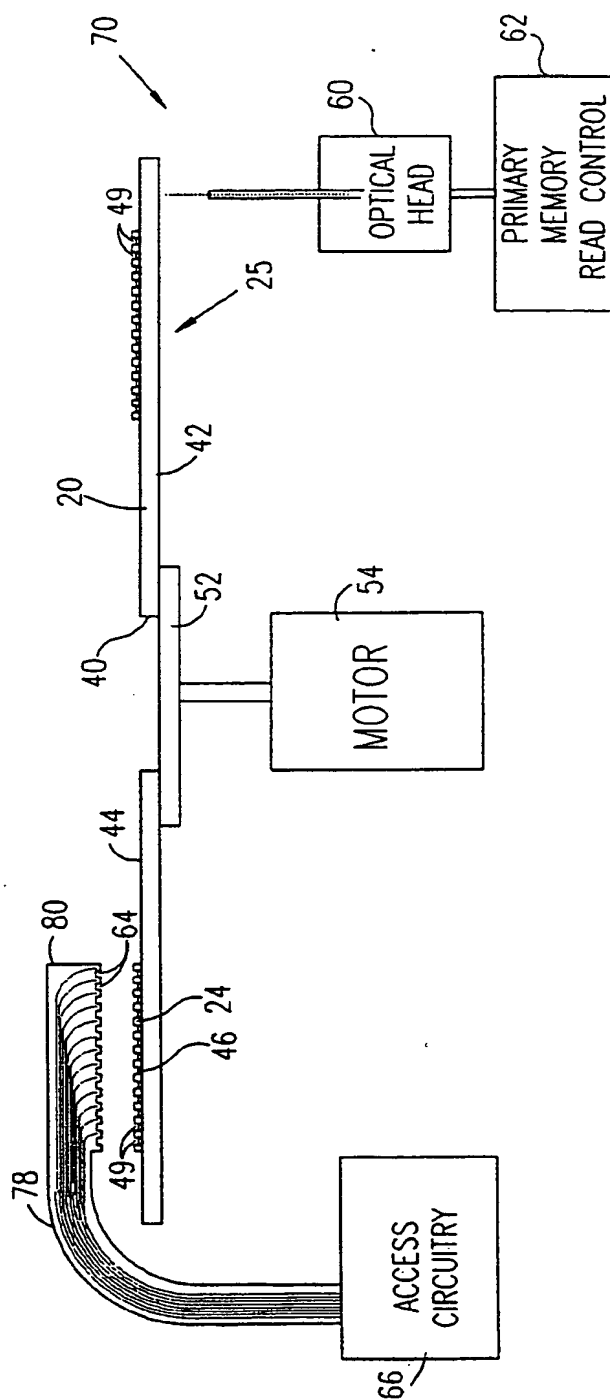


FIG. 5

FIG. 6



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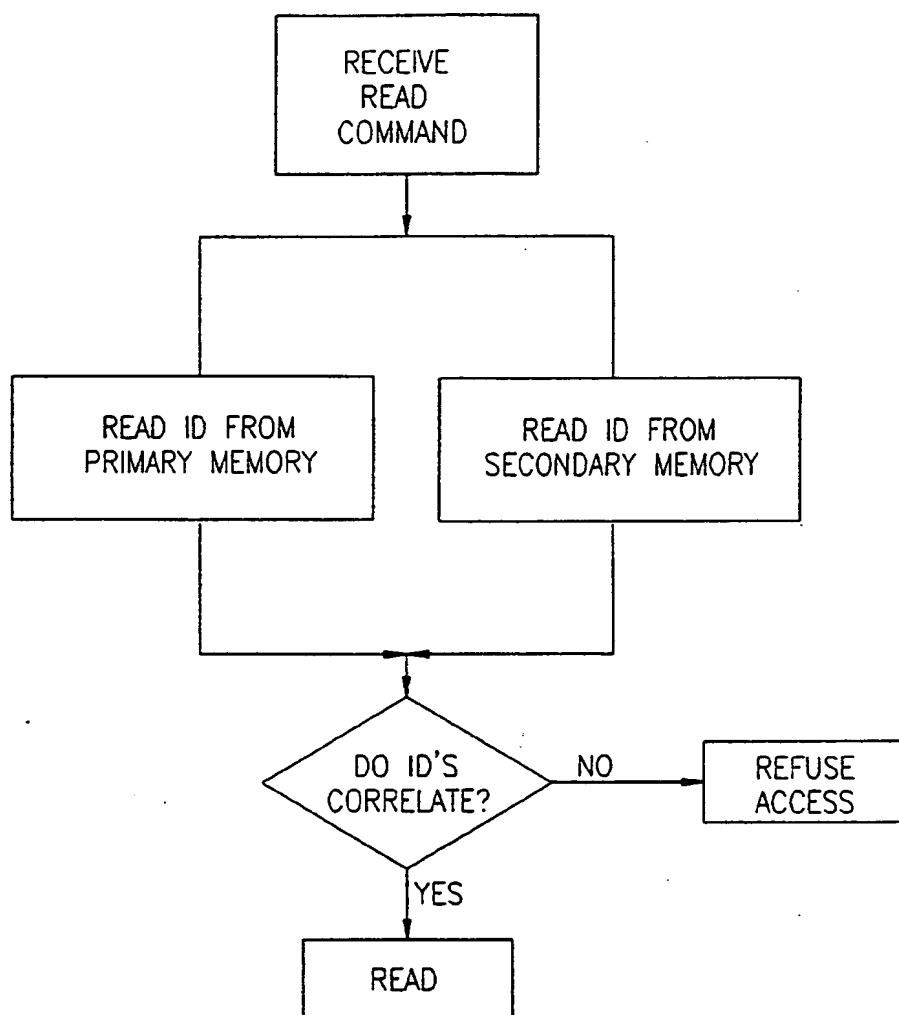
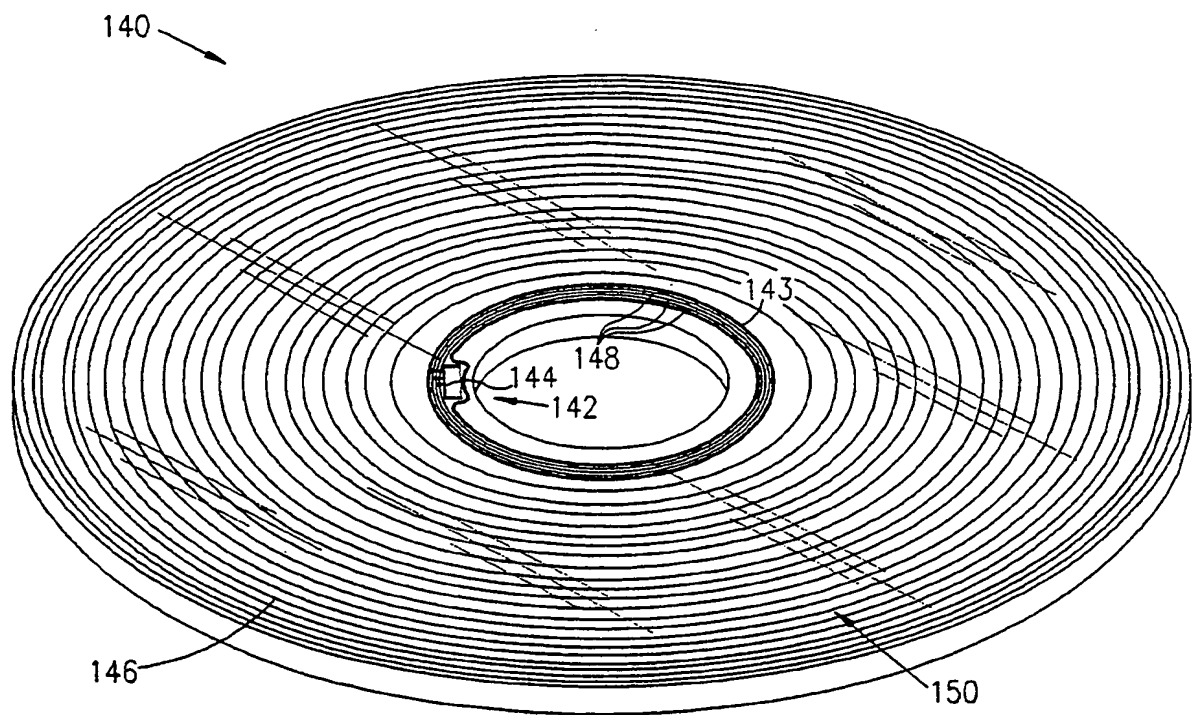


FIG. 7

FIG. 8



INTERNATIONAL SEARCH REPORT

International Application No
PCT/IL 98/00217

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 G11B7/24 G11B20/00 G11B23/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 545 532 A (HEWLETT PACKARD CO) 9 June 1993	1, 2, 4, 6-9, 12, 13, 15-17, 20, 27, 29, 30, 39, 42
A	see the whole document	3, 5, 10, 11, 14, 18, 19, 21-26, 28, 31-38, 40, 41
	--- -/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

4 September 1998

Date of mailing of the international search report

17/09/1998

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INTERNATIONAL SEARCH REPORT

Internat. Application No
PCT/IL 98/00217

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>ANONYMOUS: "MAGNETIC RECORDING DISK FILE WITH SILICON SUBSTRATE DISK CONTAINING BOTH INTEGRATED ELECTRONIC CIRCUITS AND MAGNETIC MEDIA"</p> <p>IBM TECHNICAL DISCLOSURE BULLETIN, vol. 28, no. 7, December 1985, page 2861/2862 XP002073271</p> <p>see the whole document</p>	<p>1,2, 6-10,12, 27,39,42</p>
A	<p>EP 0 600 660 A (NINTENDO CO LTD) 8 June 1994</p> <p>see the whole document</p>	<p>1-42</p>
A	<p>WO 96 29699 A (MEILLER COMCARD GMBH ;LENDER FRIEDWART (DE); HORSTER PATRICK (DE)) 26 September 1996</p> <p>see page 6, line 11 - page 9, line 3; figures 3,5</p>	<p>1-42</p>
A	<p>US 5 119 353 A (ASAKURA TORU) 2 June 1992</p> <p>cited in the application</p> <p>see the whole document</p>	

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Information on patent family members

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PCT/IL 98/00217

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